(2)

December 1990

M90-93

M. M. Weiner

Electrically-Small, Quarter-Wave, and Resonant Monopole Elements with Disk Ground Planes in Free Space

MITRE
Bedford, Massachusetts

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (*Leave blank*)

2. REPORT DATE
12/90

3. REPORT TYPE AND DATES COVERED
FINAL

4. TITLE AND SUBTITLE
ELECTICALLY-SMALL, QUATER WAVE, AND RESONANT MONOPOLE ELEMENTS WITH DISK GROUND PLANES IN FREE SPACE

5. FUNDING NUMBERS
PR = 91260

6. AUTHOR(S)
M. M. WEINER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
The MITRE Corporation
Burlington Road
Bedford MA

8. PERFORMING ORGANIZATION REPORT NUMBER
M90-93

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
The MITRE Corporation
Burlington Road
Bedford, MA

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
N/A

11. SUPPLEMENTARY NOTES
N/A

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

This paper extends previously reported results for a quarterwave monopole element on a disk ground plane in free space to include electrically-small and resonant elements. Numerical results are obtained by utilizing Richmond's method-of-moments computer program for disk ground planes in free space.

14. SUBJECT TERMS
Gain-Monopole Elements

15. NUMBER OF PAGES
13

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

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CONTRACT SPONSOR MSR
CONTRACT NO. N/A
PROJECT NO. 91260
DEPT. D085

MITRE

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ELECTRICALLY-SMALL, QUARTER-WAVE, AND RESONANT MONOPOLE ELEMENTS WITH DISK GROUND PLANES IN FREE SPACE

This paper extends previously reported results [1], [2] for quarter-wave elements on disk ground planes in free space, to include electrically-small and resonant elements. Numerical results are obtained by utilizing Richmond's method-of-moments for disk ground planes in free space [3].

The geometry is characterized by only three parameters when the parameters are normalized to the rf wavelength λ: element length h/λ, element radius b/λ, and disk radius $2\pi a/\lambda$ (see figure 1). The current on the outside of the coaxial-line feed is assumed to be zero because of attenuation by lossy ferrite toroids along the exterior of the coaxial line feed [4].

The directive gain pattern, radiation resistance, directive gain on the horizon, peak directivity, and elevation angle of peak directivity for electrically-small elements are similar to those for quarter-wave elements (see figures 2-6). The input reactances, for electrically-small and quarter-wave elements much larger than the disk radius, are negative and positive, respectively, and are approximately independent of disk radius (see figure 7).

The element lengths for first-order resonance, first-order anti-resonance, second-order resonance, and second-order anti-resonance vary by as much as 30% from the values of 0.25, 0.5, 0.75, and 1.0 wavelengths, respectively, for disk radii greater than 0.25 wavenumbers (see figures 8 and 9). Anti-resonances (but not resonances) occur for disk radii less than approximately 0.025 wavenumbers (see figures 10 and 11).

ACKNOWLEGMENT

L. W. Parker and C. R. Sharpe performed the computer runs and developed the computer plots.

REFERENCES

1. M. M. Weiner, "Monopole Element at the Center of a Circular Ground Plane of Arbitary Radius," Proceedings, PIERS 1990, July 25-26, 1990, Boston, MA, p. 216.

2. M. M. Weiner, "Monopole Element at the Center of a Circular Ground Plane Whose Radius is Small or Comparable to a Wavelength," *IEEE Trans. Ant. and Prop.*, Vol. AP-35, No. 5, May 1987, pp. 488-495.

3. M. M. Weiner, S. P. Cruze, C. C. Li, and W. J. Wilson, *Monopole Elements on Circular Ground Planes*, Norwood, MA: Artech House, 1987, pp. 45-47, 78-85.

4. op. cit. 3, pp. 12-17.

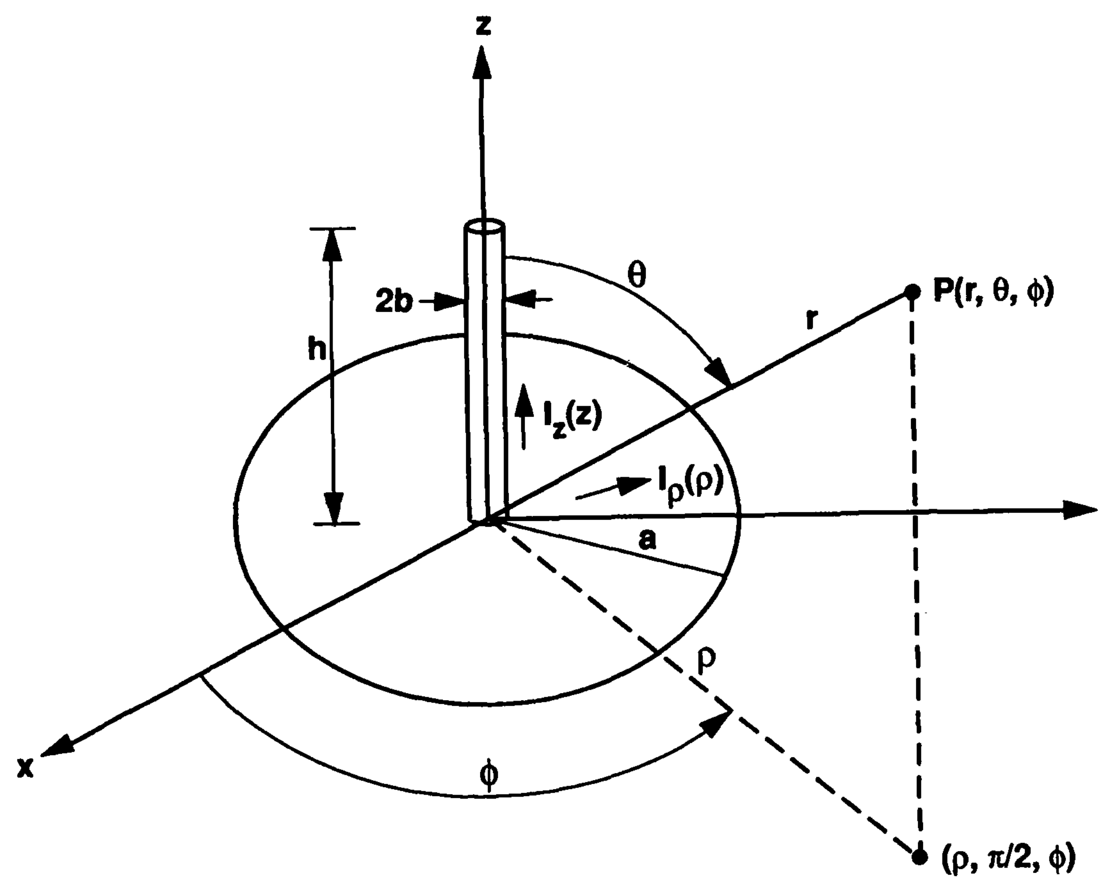


Figure 1. Antenna Geometry

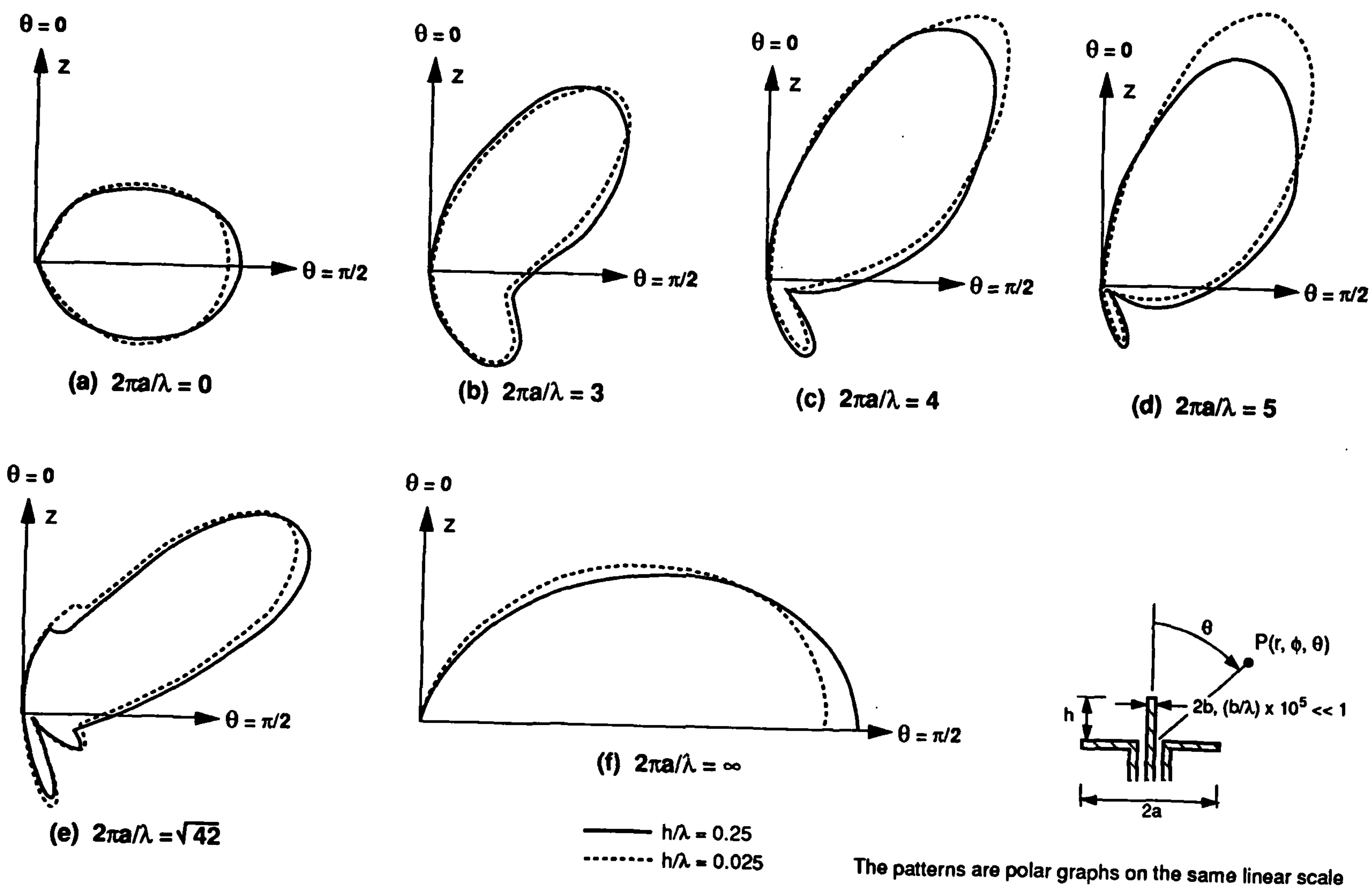


Figure 2. Directive Gain Patterns

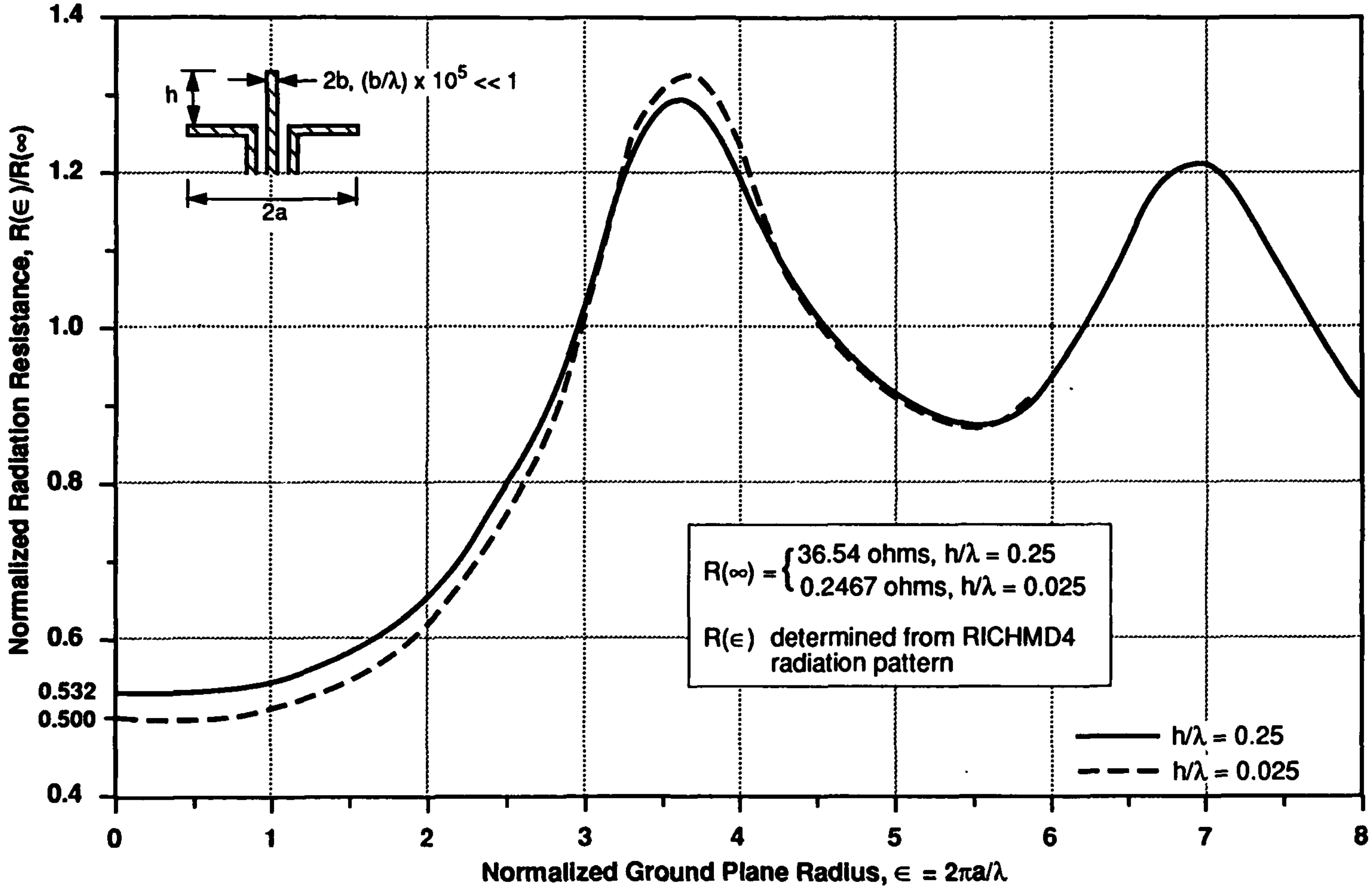


Figure 3. Radiation Resistance

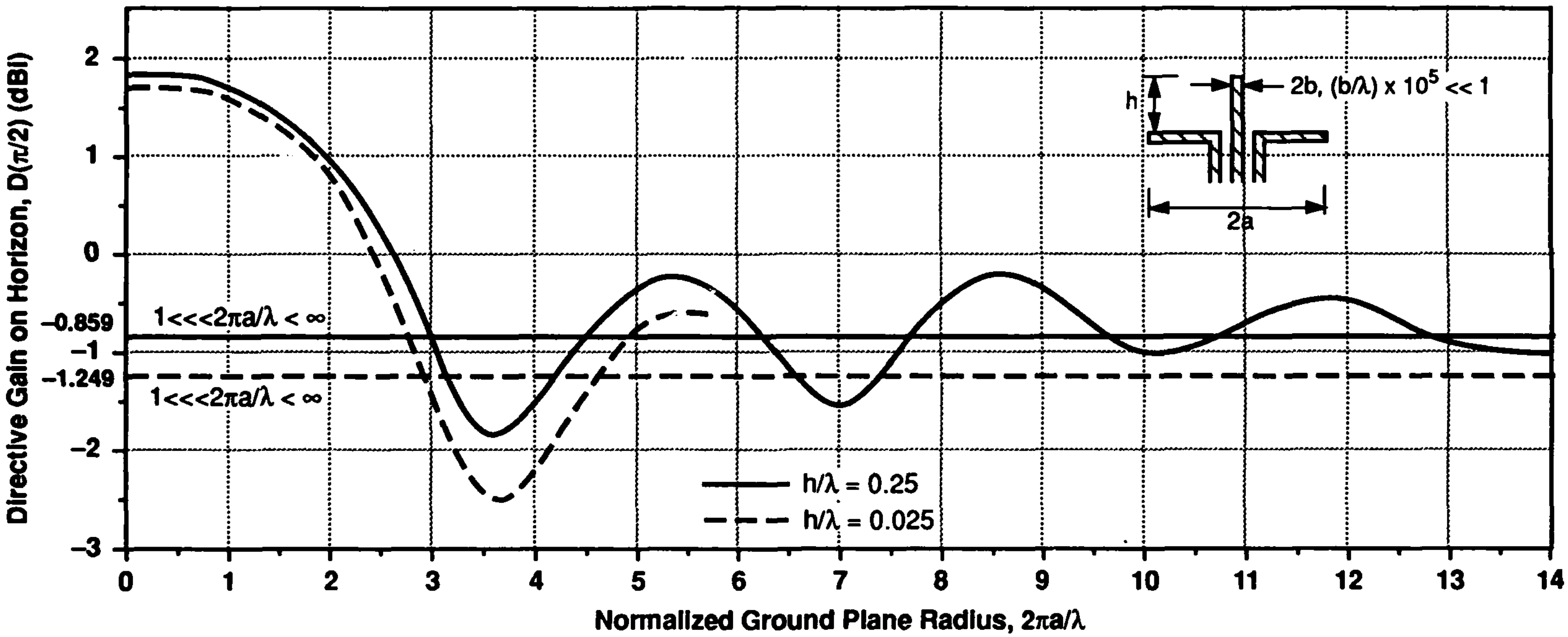


Figure 4. Directive Gain on the Horizon

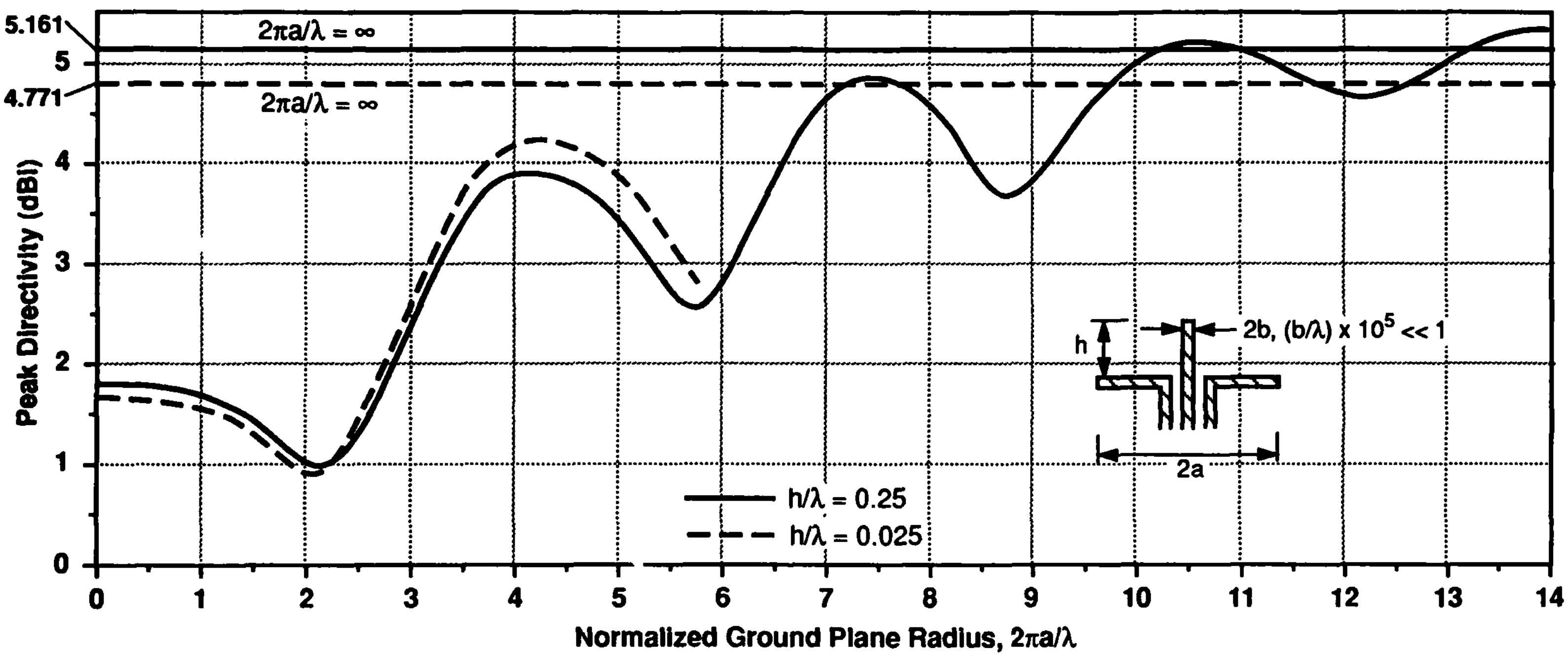


Figure 5. Peak Directivity

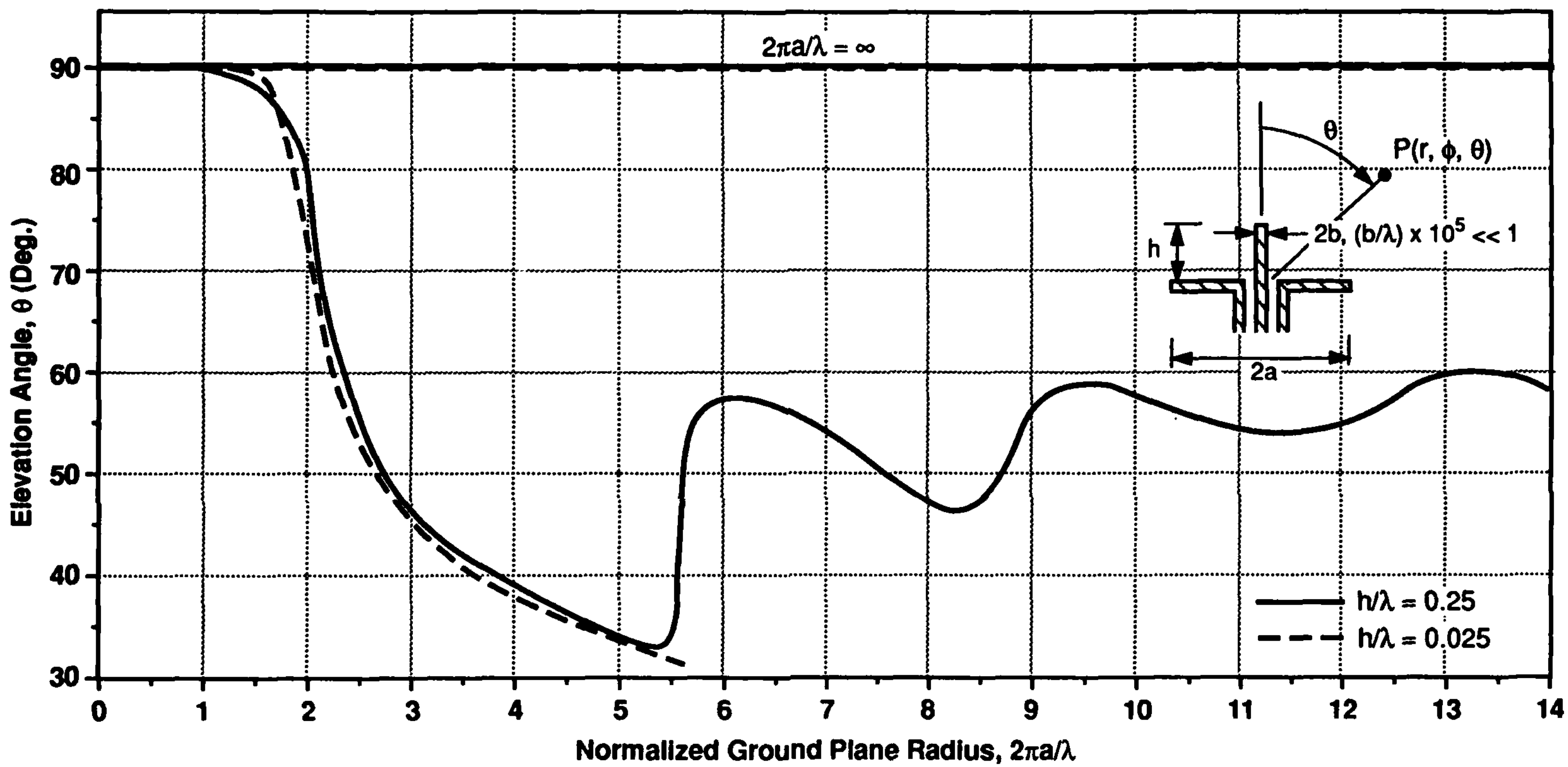
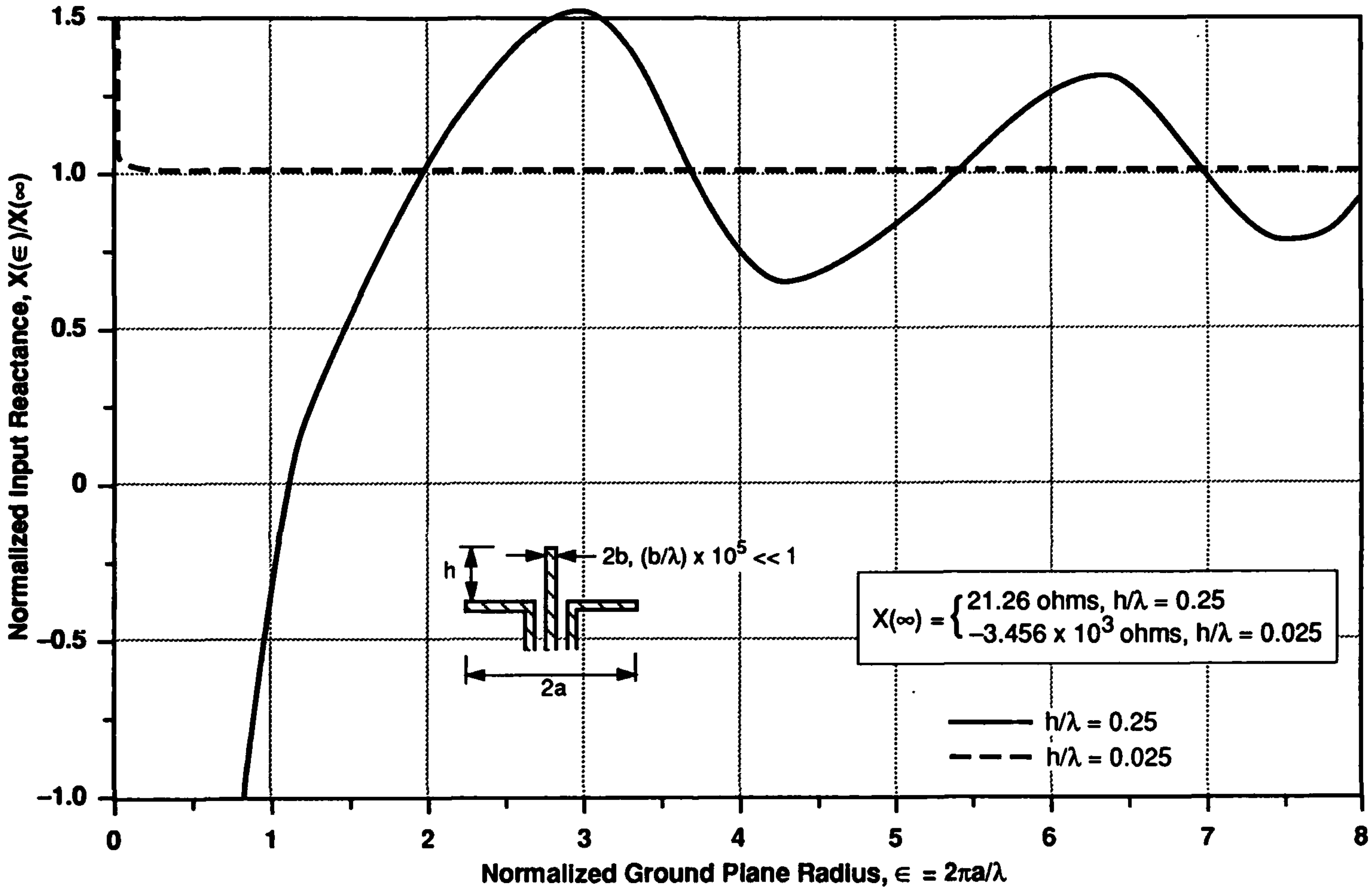


Figure 6. Elevation Angle of Peak Directivity



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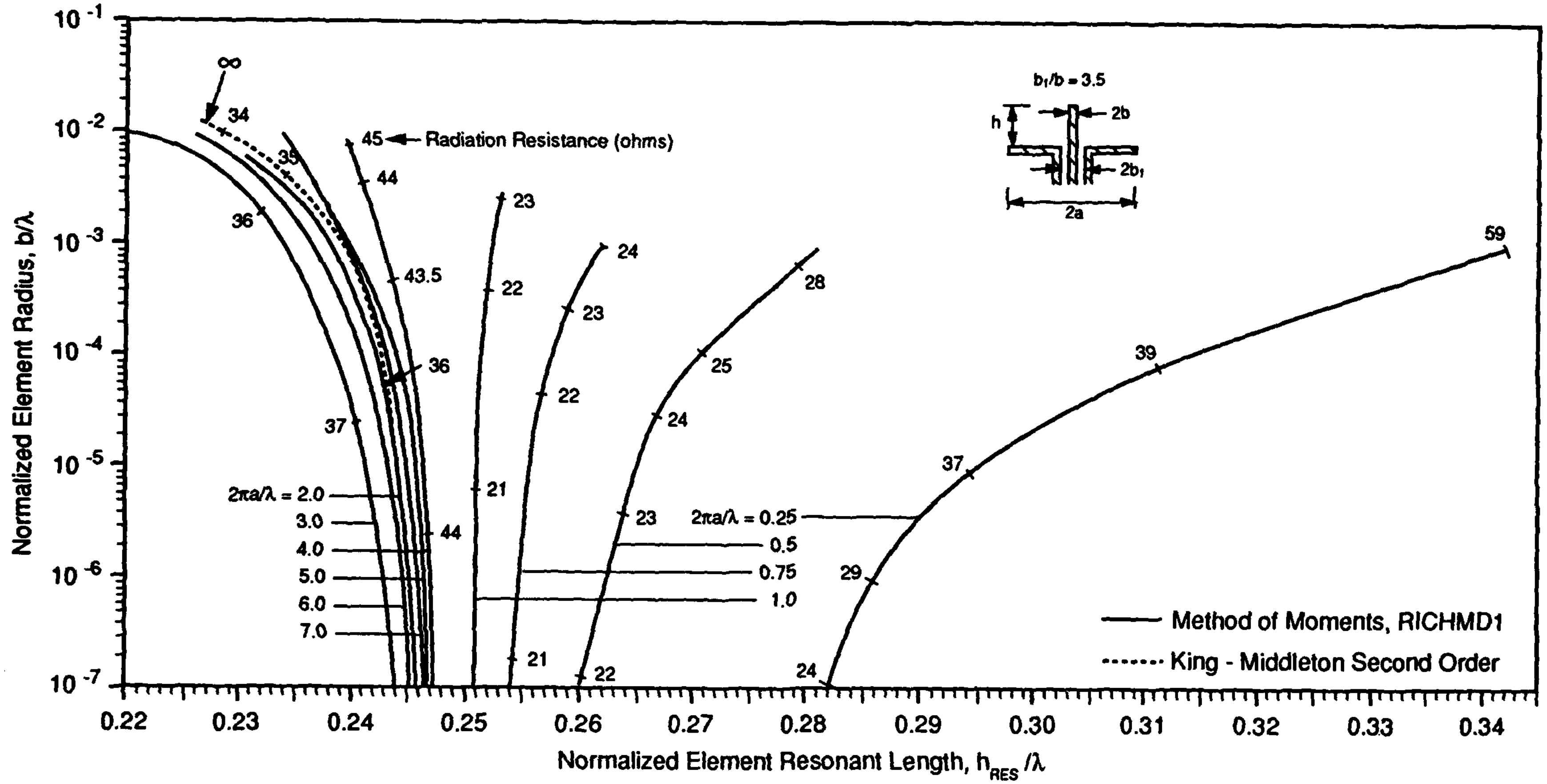
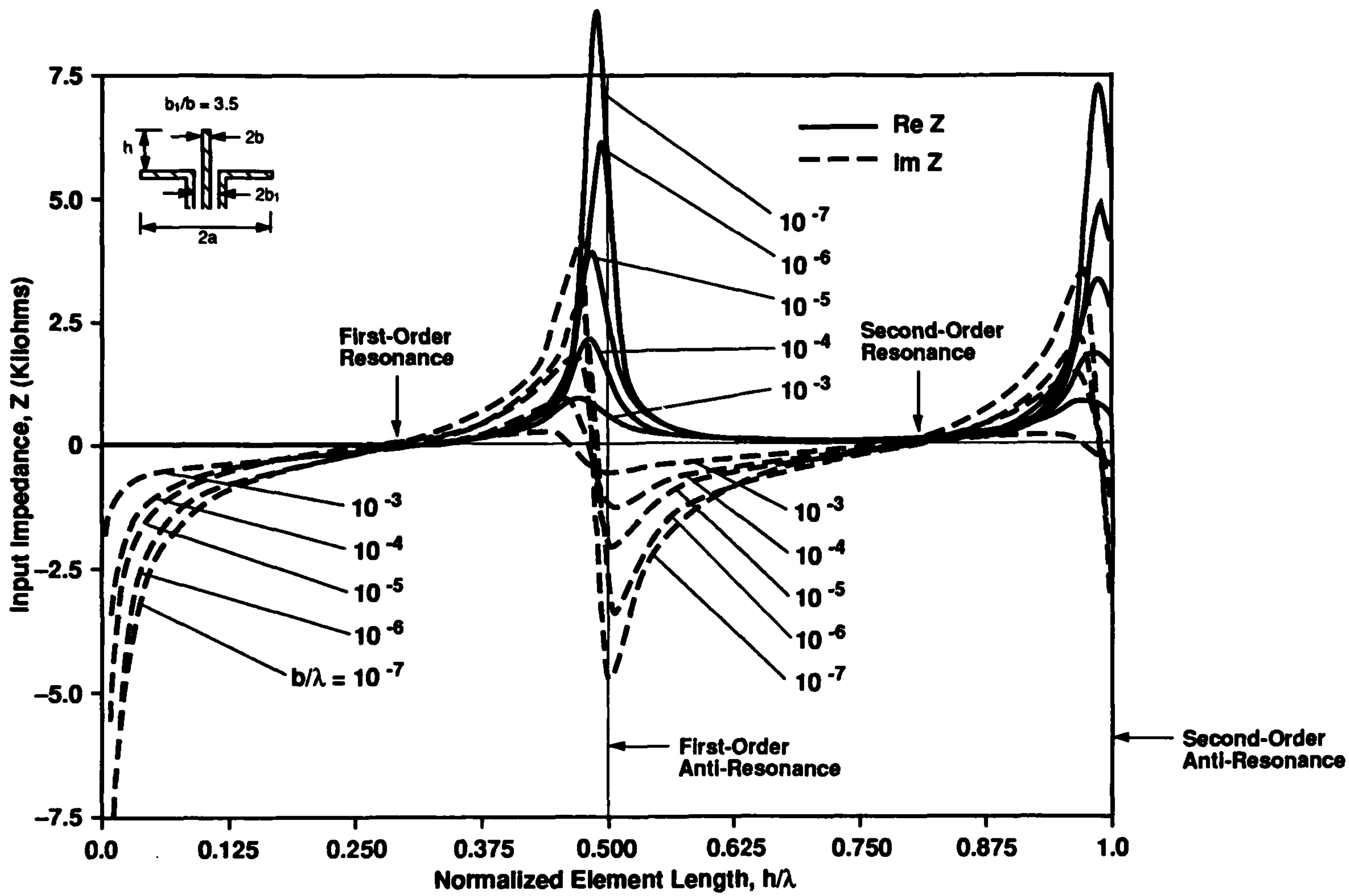


Figure 8. First-Order Resonance



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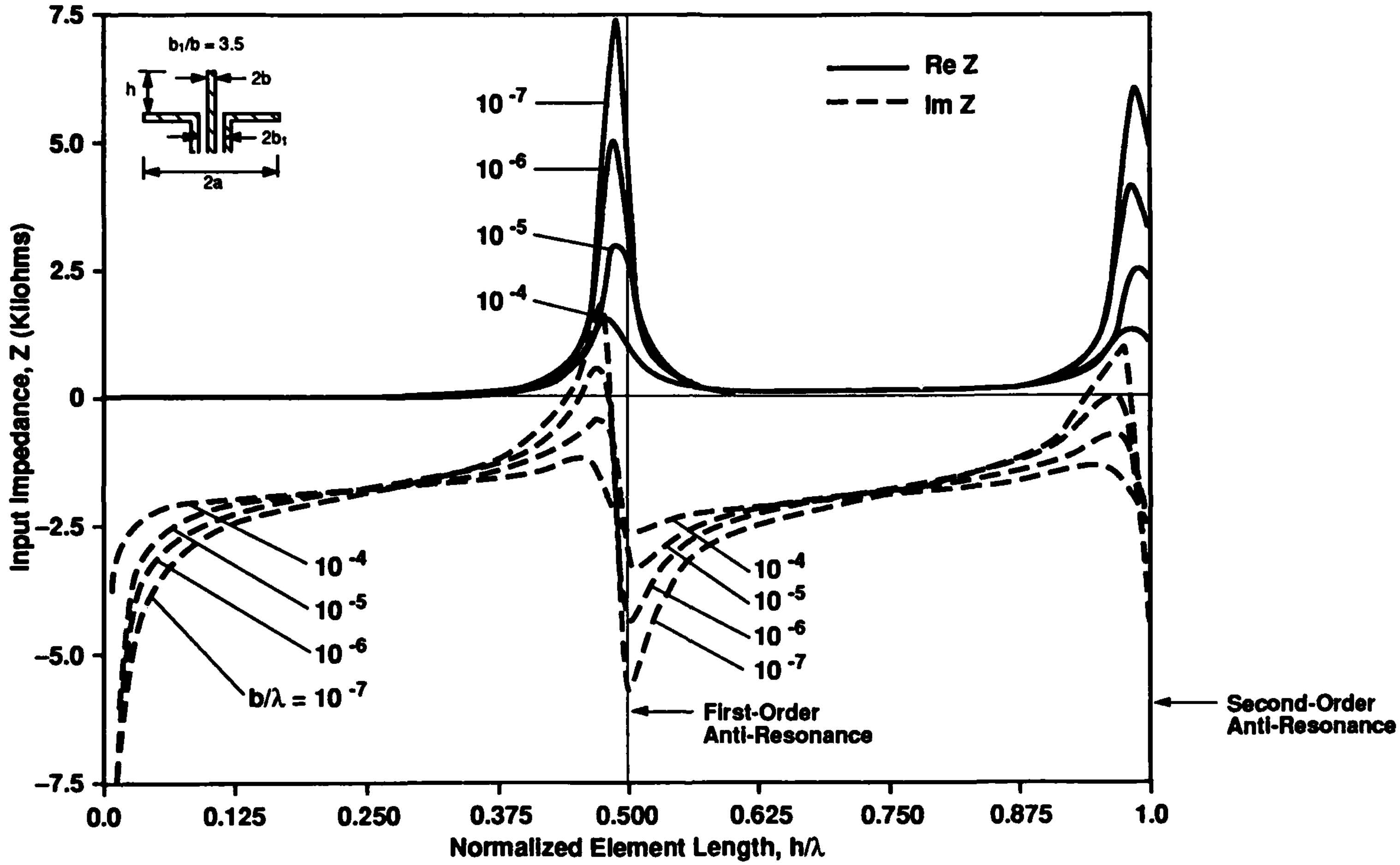
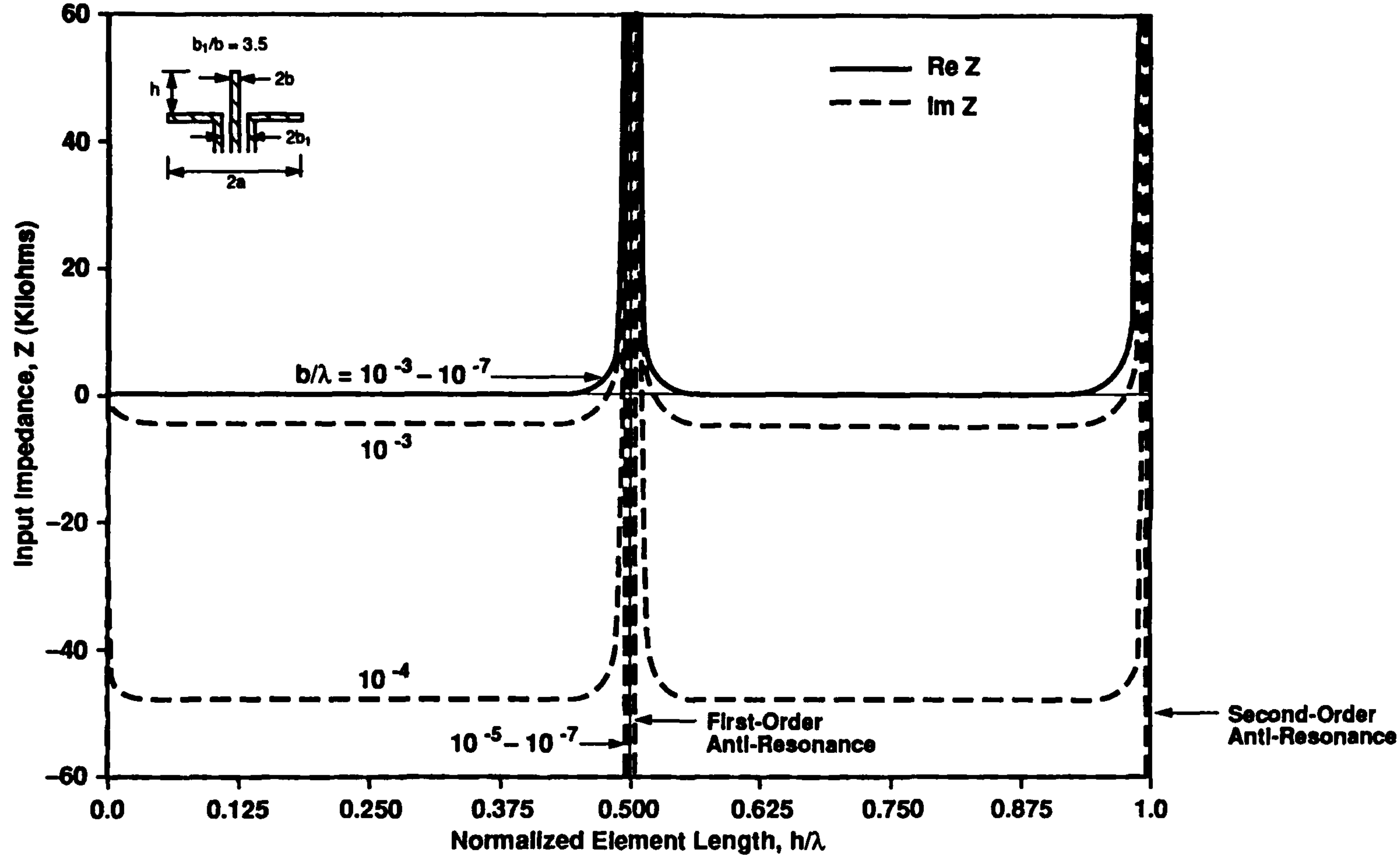


Figure 10. Input Impedance, $2\pi a/\lambda = 0.025$



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